REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
28-08-2013	Journal Article	

4. TITLE AND SUBTITLE
Advancing Reflectrometry

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
0601153N

6. AUTHOR(S)
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER
73-4260-02-5

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Research Laboratory
Oceanography Division
Stennis Space Center, MS 39529-5004

8. PERFORMING ORGANIZATION REPORT NUMBER
NRL/JA/7330--13-1606

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
One Liberty Center
875 North Randolph Street, Suite 1425
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Reflectometry, a microwave remote sensing technique to extract geophysical data from scattered satellite transmissions, was first demonstrated using Global Navigation Satellite System (GNSS) reflections. Recently, reflectometry has been extended to digital communication satellite `signals of opportunity', expanding its application to most microwave bands that penetrate the Earth's atmosphere. The 2012 GNSS+R workshop provided an opportunity for engineers and Earth scientists to assess the state of the art, demonstrate new applications, and discuss potential missions.

15. SUBJECT TERMS
Reflectometry, Ocean Winds, Global Navigation Satellites, Communication Satellites

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Derek Burrage
Unclassified	Unclassified	Unclassified	UU	1	19b. TELEPHONE NUMBER *(Include area code)* (228) 688-5241

MEETING

Advancing Reflectometry

Workshop on Reflectometry Using GNSS and Other Signals of Opportunity (GNSS+R); West Lafayette, Indiana, 10–11 October 2012

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Reflectometry, a microwave remote-sensing technique to extract geophysical data from scattered satellite transmissions, was first demonstrated using Global Navigation Satellite System (GNSS) reflections. Recently, reflectometry has been extended to the reutilization of digital communication satellite signals for Earth remote sensing, now referred to as "signals of opportunity." This expands the application of reflectometry to most microwave bands that penetrate the Earth's atmosphere. GNSS+R 2012 provided an opportunity for engineers and Earth scientists to assess the state of the art, demonstrate new applications, and discuss potential missions.

Reflectometry experiments from ground, air, and space platforms were presented at the meeting. New results from ground experiments included studies of snow layering in Antarctica, soil moisture/vegetation sensing, and tide measurements. Recent airborne and coastal measurements using S and K_u band satellite signals were also presented, showing expansion of reflectometry to higher frequencies and signal powers. The 2005 United Kingdom Disaster Monitoring Constellation (UK-DMC) space demonstration was discussed, and NASA's recently initiated Cyclone Global Navigation Satellite System (CYGNSS) mission was highlighted. Slated for launch in 2016, CYGNSS will make 3-hourly GNSS+R ocean wind measurements in tropical regions.

A town hall meeting, held on the second day of the conference, focused on how to better engage the Earth sciences user community and on potential satellite missions. While most of the reflectometry community is based in engineering, the need to involve Earth scientists to help identify data gaps in existing measurements and develop appropriate specifications for reflectometry products was recognized. For example, useful GNSS+R altimetry products must have precision better than 5 centimeters within a 50-kilometer footprint. A potential constellation combining the American, Russian, Chinese, and European GNSS transmitters could provide shorter revisit times and enable new measurement types. Reflectometry could also be integrated with other instruments, for instance, to correct microwave radiometer salinity retrievals for roughness effects or to perform coastal altimetry with high-power direct-broadcast satellites with footprints covering continental areas.

Participants agreed that with CYGNSS as a pathfinder, future constellations could be scaled up to more satellites, further decreasing revisit time. Forty-eight low-Earth-orbiting satellites in a polar orbit would provide 15-minute revisit times, offering an alternative to the geostationary orbit, with advantages of scalability, small low-cost satellites, and robustness to single-satellite failures.

The utility of more fundamental data products, unique to reflectometry (e.g., delay-Doppler maps and directional mean square slope), was also discussed. Such products, if directly assimilated into models (as is done with radio-occultation bending angles), could improve model outputs, despite difficulties finding adequate surface truth for calibration and validation. At present, reflectometry measurements are reduced to well-known geophysical units (e.g., wind speed, volumetric water content, snow depth).

Missions of opportunity were discussed as potential hosts for reflectometry instrument payloads. While the idea is attractive, past experience has shown that it is often difficult to accommodate a secondary reflectometry payload unless it contributes vitally to the primary mission.

GNSS+R 2012 was jointly sponsored by NASA and the Institute of Electrical and Electronics Engineers Geoscience and Remote Sensing Society.

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